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LOCKHEED MARTIN

DATE: April 23, 2007

TO: Mark Sprenger, U.S. EPA/ERT Work Assignment Manager

FROM: Deborah Killeen, REAC Quality Assurance Officer

SUBJECT: DOCUMENT TRANSMITTAL UNDER WORK ASSIGNMENT 0-201

Attached please find the following document(s) revised and prepared under this work assignment:

REVISED DATA EVALUATION REPORT
EVALUATION OF PLANT AND MAMMAL TISSUE RESULTS

cc: Central File WA 0-201 (w/attachment)
William Coakley, ERT QA Coordinator (w/attachment)
Dennis Miller, REAC Program Manager
Daniel Cooke, REAC Task Leader

0201-DDERR1-042307

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DATE: April 23, 2007

TO: Mark Sprenger, U.S. EPA/ERT Work Assignment Manager

THROUGH: Dan Cooke, REAC Task Leader

FROM: Deborah Killeen, REAC Quality Assurance Officer

SUBJECT: EVALUATION OF PLANT AND MAMMAL TISSUE RESULTS – RINGWOOD BIOLOGICAL SAMPLING SITE
WORK ASSIGNMENT #0-201 – DATA EVALUATION REPORT

This data evaluation report was prepared in response to your request for an acceptance or rejection statement regarding the plant and mammal tissue metal concentrations, specifically for copper and zinc. During data review conducted by the Environmental Response Team (ERT) Biology Work Assignment Manager (WAM) and the ERT Quality Assurance (QA) Coordinator, it was noted that copper and zinc concentrations for several mammal tissue samples processed during the October/November 2006 time period were higher than typically expected for that type of mammal. Those concentrations would be detrimental to the animals' survival and therefore questionable. Since lead was one of the contaminants of concern, ratios of copper to lead and zinc to lead were calculated. Copper to lead ratios in the samples in question ranged from 20:1 to 25:1, and zinc to lead ratios ranged from 12:1 to 15:1.

On February 23, 2007, REAC personnel conducted a study using deer tissue in the REAC Tissue Laboratory to evaluate the condition of each of the blenders used for tissue processing and homogenization. Each of the 11 working blenders was assigned a number prior to the study. A portion of the same deer tissue was processed and homogenized in each of the blenders and transferred to the REAC Laboratory for metals analysis. The same non-homogenized deer sample was also submitted to the laboratory as a control for this study.

During sample preparation, REAC inorganic personnel noted the presence of metal shavings in one of the deer tissue samples that was processed in blender #4 and notified the Analytical Section Leader and Quality Assurance Officer (QAO). This sample was also analyzed as a laboratory duplicate to determine if the resulting copper, zinc and lead concentrations would vary due to the presence of these shavings and as a measure of precision. Results can be found in Table 1.

At the same time, a sample from blender #4 of the metal shavings from the nickel-plated brass cap nut and bearing cap that holds the stainless steel blade in place were collected and submitted for analysis. Results can be found in Table 2. Based on information supplied by the manufacturer of the blenders, the assembly is internally lubricated. When the lubrication eventually wears out, it cannot be refilled. Until the shavings were visibly present in blender #4, there was no prior indication that these parts were wearing out until the tissue sample results were evaluated.

Results for the deer tissue study were then evaluated to determine if the copper to lead ratios and zinc to lead ratios were similar to that obtained for the metal shavings. The copper to lead results for the deer tissue samples processed in blenders 4, 8 and 10 fell within a range of 20:1 to 25:1, similar to the ratio obtained for the metal shavings of 22:1. Likewise, the zinc to lead ratios for these same samples fell within a range of 12:1 to 15:1; the zinc to lead ratio for the metal shavings was 14:1.

To further provide evidence that the contamination was caused by the degradation of the blade assembly used in the REAC Tissue Laboratory, upper tolerance limits (UTLs) were computed for copper and zinc. Lead was omitted

from the computations due to the large number of non-detects. Since the blenders in question were #4, #8 and #10, copper and zinc data from these blenders were excluded for the initial test of normality, which is a required assumption for UTL computations. Kolmogorov-Smirnov's test for normality was applied using SigmaStat software, version 3.0.

For both copper and zinc, UTLs with 99 percent (%) coverage and 99% confidence were computed to be able to state that there is a 99% confidence that no greater than 1% of the copper and zinc measurements in the remaining deer tissue sample will exceed these computed values (Table 3). For copper, the 99% computed UTL was 8.08 milligrams per kilogram (mg/kg) and for zinc, the 99% computed UTL was 232.21 mg/kg.

Copper results for the deer tissue samples processed in blenders #4, #8 and #10 and the laboratory duplicate prepared from Blender #4 were 3290, 236, 1450 and 7090 mg/kg, respectively. These four results greatly exceed the UTL of 8.08 mg/kg. Zinc results for the same samples were 2020, 322, 959 and 4020 mg/kg, respectively. All exceed the UTL of 232.21 mg/kg. Based on this study, the UTLs provide evidence of metal shavings contamination from the blenders.

Copper, lead and zinc data for the mammal and plant tissue samples collected from the Ringwood Biological site are presented in Tables 4 through 8. The potentially affected mammal and plant tissue data were evaluated based on the ratios calculated for the metal shavings. The copper to lead ratio was 22:1 and the zinc to lead ratio was 14:1. The overall ratio of copper to zinc was 1.6:1. The ratios for copper to lead and zinc to lead must both be similar to reject the data.

Copper, zinc and lead concentrations for the northern short-tailed shrew, white-footed mouse, woodland vole, squirrel, crayfish, frog and root tissue were plotted on XY scatter graphs for both copper versus lead and zinc versus lead. This allowed for visual observation of the copper, zinc and lead results for the various species (Figures 1 though 14). The metal results for the meadow vole, white feeder mice (used for the MS/MSD) or the southern red-backed vole were not plotted, as there were not a sufficient number of samples for comparison.

For the northern short-tailed shrew, samples collected from sample locations 2-3-11 and 3-4-11 had copper to lead ratios similar to the metal shavings collected from blender #4 in ratios of 22:1 and 20:1, respectively. The white-footed mouse collected from sample locations 2-1-10 and 4-2-2 had copper to lead ratios of 24:1 and 23:1. The squirrel sample collected from sample location OB-17A had a copper to lead ratio of 23:1. Similarly, the samples collected from sample locations 2-3-11 and 3-4-11 had zinc to lead ratios similar to the metal shavings collected from blender #4 in ratios of 13:1 and 12:1, respectively. The white-footed mouse collected from sample locations 2-1-10 and 4-2-2 had zinc to lead ratios of 14:1. The squirrel sample collected from sample location OB-17A had a zinc to lead ratio of 15:1. Refer to Tables 4 and 5.

Based on professional judgment and weight of evidence, it is recommended that the samples identified above be excluded from the sampling set.

cc: Central File WA 0-201 (w/attachment)
William Coakley, ERT QA Coordinator
Dennis Miller, REAC Program Manager (w/o attachment)

TABLE 1. Blender Study- Copper, Lead and Zinc Results in Deer Tissue Samples

Sample Identification	Copper, mg/kg DW	Lead, mg/kg DW	Zinc, mg/kg DW
Blender 1	6.48	2.50 U	174
Blender 2	5.79	2.31 U	109
Blender 3	5.99	2.40 U	112
Blender 4	3290	130	2020
Blender 4 DUP	7090	267	4210
Blender 5	6.09	2.64 U	165
Blender 6	5.83	2.48 U	155
Blender 7	7.34	2.56 U	116
Blender 8	236	6.32	322
Blender 9	5.38	2.40 U	102
Blender 10	1450	50.9	959
Blender 11	5.87	2.56 U	96.4
Unprocessed Deer Tissue	7.39	2.57 U	149

DUP = Laboratory Duplicate
mg/kg DW = milligrams per kilogram dry weight
U = Not Detected

TABLE 2. Blender Study – Copper, Lead and Zinc Results in Metal Shavings

Sample Identification	Copper, mg/sample	Lead, mg/sample	Zinc, mg/sample	Copper/Lead Ratio	Zinc/Lead Ratio	Copper/Zinc Ratio
Metal Shavings	0.904	0.0405	0.550	22.3	13.6	1.6

mg = milligrams

TABLE 3. Calculation of 99% Upper Tolerance Limits for Deer Tissue Samples

Sample Identification	Copper, mg/kg DW	Zinc, mg/kg DW
Blender 1	6.48	174
Blender 2	5.79	109
Blender 3	5.99	112
Blender 5	6.09	165
Blender 6	5.83	155
Blender 7	7.34	116
Blender 9	5.38	102
Blender 11	5.87	96.4
N	7	7
Average	6.09625	128.675
Standard Deviation	0.58972	30.1826
UTL*	8.077714	232.2056

mg/kg DW = milligrams per kilogram dry weight
* = Critical t-value for 6 degrees of freedom, one-tailed = 3.143 and 99% confidence, K-multiplier = 3.360008
** = Normality test was only applied to blenders that were not suspected of causing contamination (USEPA, Statistical Training Course for Ground-water Monitoring Data Analysis. Office of Solid Waste and Emergency Response. EPA530-R-93-003. 1992

TABLE 4. Copper, Lead and Zinc Results for Small Mammal Tissue
Results in mg/kg DW

Sample Location	Tissue Type	Copper	Lead	Flag	Zinc	Copper/Lead*	Zinc/Lead*	Copper/Zinc
2-3-7	Meadow Vole	8.68	4.49		100	1.93	22.3	0.0868
1-1-2	Northern Short-Tailed Shrew	12.0	9.26		110	1.30	11.9	0.109
1-3-6	Northern Short-Tailed Shrew	8.91	7.26		96.8	1.23	13.3	0.0920
2-1-9	Northern Short-Tailed Shrew	16.2	18.6		132	0.871	7.10	0.123
2-2-5	Northern Short-Tailed Shrew	14.9	64.8		137	0.230	2.11	0.109
2-2-6	Northern Short-Tailed Shrew	11.4	7.34		110	1.55	15.0	0.104
2-3-11	Northern Short-Tailed Shrew	6500	292		3820	22.3	13.1	**1.70**
2-4-8	Northern Short-Tailed Shrew	9.18	21.9		98.5	0.419	4.50	0.0932
3-4-11	Northern Short-Tailed Shrew	2450	123		1490	19.9	12.1	**1.64**
4-4-1	Northern Short-Tailed Shrew	12.7	2.9		125	4.38	43.1	0.102
3-3-7	Southern Red-Backed Vole	9.48	2.3	U	89.8	4.12	39.0	0.106
Reference	White Feeder Mice	167	7.21		188	23.2	26.1	0.888
1-1-12	White-Footed Mouse	11.1	3.10		92.0	3.58	29.7	0.121
1-3-8	White-Footed Mouse	8.61	2.01	U	102	4.28	50.7	0.0844
1-4-7	White-Footed Mouse	11.2	3.13		94.0	3.58	30.0	0.119
2-1-10	White-Footed Mouse	4670	199		2770	23.5	13.9	**1.69**
2-1-6	White-Footed Mouse	12.8	2.32	U	90.6	5.52	39.1	0.141
3-2-15a	White-Footed Mouse	12.8	2.41	U	110	5.31	45.6	0.116
3-2-15b	White-Footed Mouse	9.57	4.69		88.2	2.04	18.8	0.109
3-2-5	White-Footed Mouse	12.1	2.42		112	5.00	46.3	0.108
3-4-12	White-Footed Mouse	10.4	2.4	U	95.3	4.33	39.7	0.109
4-2-12	White-Footed Mouse	9.71	2.29	U	91.7	4.24	40.0	0.106
4-2-2	White-Footed Mouse	2810	120		1700	23.4	14.2	**1.65**
4-2-9	White-Footed Mouse	9.1	2.03	U	98	4.48	48.3	0.0929
4-3-12	White-Footed Mouse	11.7	3.01		119	3.89	39.5	0.0983
4-3-8	White-Footed Mouse	14.7	2.15	U	98.3	6.84	45.7	0.150
4-4-8	White-Footed Mouse	13.9	2.37	U	102	5.86	43.0	0.136
2-2-4	Woodland Vole	28.9	11.2		123	2.58	11.0	0.235
2-3-10	Woodland Vole	10.2	6.7		116	1.52	17.3	0.0879
2-4-6a	Woodland Vole	10.3	14.1		104	0.730	7.38	0.0990
2-4-6b	Woodland Vole	8.4	14.3		88.4	0.590	6.18	0.0954
4-1-7	Woodland Vole	9.62	1.9	U	86.6	5.06	45.6	0.111

mg/kg DW = milligrams per kilogram dry weight
U = Not Detected
* = Ratio for lead calculated using the reporting limit when lead is not detect

TABLE 5. Copper, Lead and Zinc Results for Squirrel Tissue
Results in mg/kg DW

Sample Location	Species	Copper	Lead	Flag	Zinc	Copper/Lead*	Zinc/Lead*	Copper/Zinc
OB17-A	Squirrel Tissue	1180	50.7		748	23.3	14.8	**1.58**
OB17-B	Squirrel Tissue	5.96	2.15	U	70.4	2.77	32.7	0.0847
OB17-C	Squirrel Tissue	5.87	2.45	U	70.2	2.40	28.7	0.0836
OB17-D	Squirrel Tissue	5.37	2.27	U	65.0	2.37	28.6	0.0826
SWTP-73A	Squirrel Tissue	6.09	2.38	U	65.9	2.56	27.7	0.0924
SWTP-73B	Squirrel Tissue	4.93	2.42	U	56.8	2.04	23.5	0.0868

TABLE 6. Copper, Lead and Zinc Results for Crayfish Tissue
Results in mg/kg DW

Sample Location	Species	Copper	Lead	Flag	Zinc	Copper/Lead*	Zinc/Lead*	Copper/Zinc
Loc 3-1	Crayfish Tissue	20.1	0.649	U	20.8	31.0	32.0	0.966
Loc 4-1	Crayfish Tissue	78.3	2.47	U	111	31.7	44.9	0.705
Loc 4-2	Crayfish Tissue	83.3	2.98	U	100	28.0	33.6	0.833
Loc 4-3	Crayfish Tissue	77.5	2.26	U	91.4	34.3	40.4	0.848
Loc 4-4	Crayfish Tissue	83.1	2.90	U	80.4	28.7	27.7	1.03
Loc 4-5	Crayfish Tissue	80.8	2.81	U	87.4	28.8	31.1	0.924

TABLE 7. Copper,Lead and Zinc Results in Frog Tissue
Results in mg/kg DW

Sample Location	Species	Copper	Lead	Flag	Zinc	Copper/Lead*	Zinc/Lead*	Copper/Zinc
Kam Man Food Market-1	Frog Tissue	7.54	3.17	U	158	2.38	49.8	0.0477
Loc 1-1	Frog Tissue	56.5	4.59		99.5	12.3	21.7	0.568
Loc 1-2	Frog Tissue	19.4	2.40	U	82.7	8.08	34.5	0.235
Loc 1-3	Frog Tissue	7.14	2.53	U	82.6	2.82	32.6	0.0864
Loc 1-4	Frog Tissue	6.63	3.07	U	80.2	2.16	26.1	0.0827
Loc 1-5	Frog Tissue	32.0	3.79	U	104	8.44	27.4	0.308
Loc 3-1	Frog Tissue	10.4	2.61	U	59.0	3.98	22.6	0.176
Loc 3-2	Frog Tissue	4.82	3.13	U	76.5	1.54	24.4	0.0630
Loc 3-3	Frog Tissue	6.06	2.98	U	89.1	2.03	29.9	0.0680
Loc 3-4	Frog Tissue	8.28	2.93	U	58.1	2.83	19.8	0.143
Loc 4-1	Frog Tissue	3.15	2.27	U	74.6	1.39	32.9	0.0422
Loc 4-2	Frog Tissue	6.02	2.53	U	79.4	2.38	31.4	0.0758
Loc 4-3	Frog Tissue	9.18	3.40	U	56.3	2.70	16.6	0.163
Loc 4-4	Frog Tissue	9.56	3.57	U	73.4	2.68	20.6	0.130
Loc 4-5	Frog Tissue	5.10	6.71		87.8	0.760	13.1	0.0581
Loc 4-5D	Frog Tissue	4.90	5.72		82.4	0.857	14.4	0.0595

mg/kg DW = milligrams per kilogram dry weight
U = Not Detected
* = Ratio for lead calculated using the reporting limit when lead is not detected

TABLE 8. Copper, Lead and Zinc Results for Root Tissue
Results in mg/kg DW

Sample Location	Species	Copper	Lead	Flag	Zinc	Copper/Lead*	Zinc/Lead*	Copper/Zinc
Loc 1-1	Root Tissue	12.6	28.4		72.2	0.444	2.54	0.175
Loc 1-2	Root Tissue	9.79	3.63		49.3	2.70	13.6	0.199
Loc 1-3	Root Tissue	18.1	4.88		44.7	3.71	9.16	0.405
Loc 2-1	Root Tissue	7.13	6.62		49.9	1.08	7.54	0.143
Loc 2-2	Root Tissue	13.3	12.6		58.1	1.06	4.61	0.229
Loc 2-3	Root Tissue	14.2	48.4		47.3	0.293	0.977	0.300
Loc 3-1	Root Tissue	8.04	8.62		88.7	0.933	10.3	0.0906
Loc 3-2	Root Tissue	11.1	3.55		39.9	3.13	11.2	0.278
Loc 3-3	Root Tissue	6.88	12.3		86.9	0.559	7.07	0.0792
Loc 3-3D	Root Tissue	6.99	2.96	U	33.5	2.36	11.3	0.209
Loc 4-1	Root Tissue	13.1	12.6		35.0	1.04	2.78	0.374
Loc 4-2	Root Tissue	5.20	5.83		40.2	0.892	6.90	0.129
Loc 4-3	Root Tissue	8.51	2.37	U	43.7	3.59	18.4	0.195

mg/kg DW = milligrams per kilogram dry weight
U = Not Detected
* = Ratio for lead calculated using the reporting limit when lead is not detected

FIGURE 1. Comparison of Copper (mg/kg) and Lead (mg/kg)
Northern Short-Tailed Shrew
Ringwood Mine Site

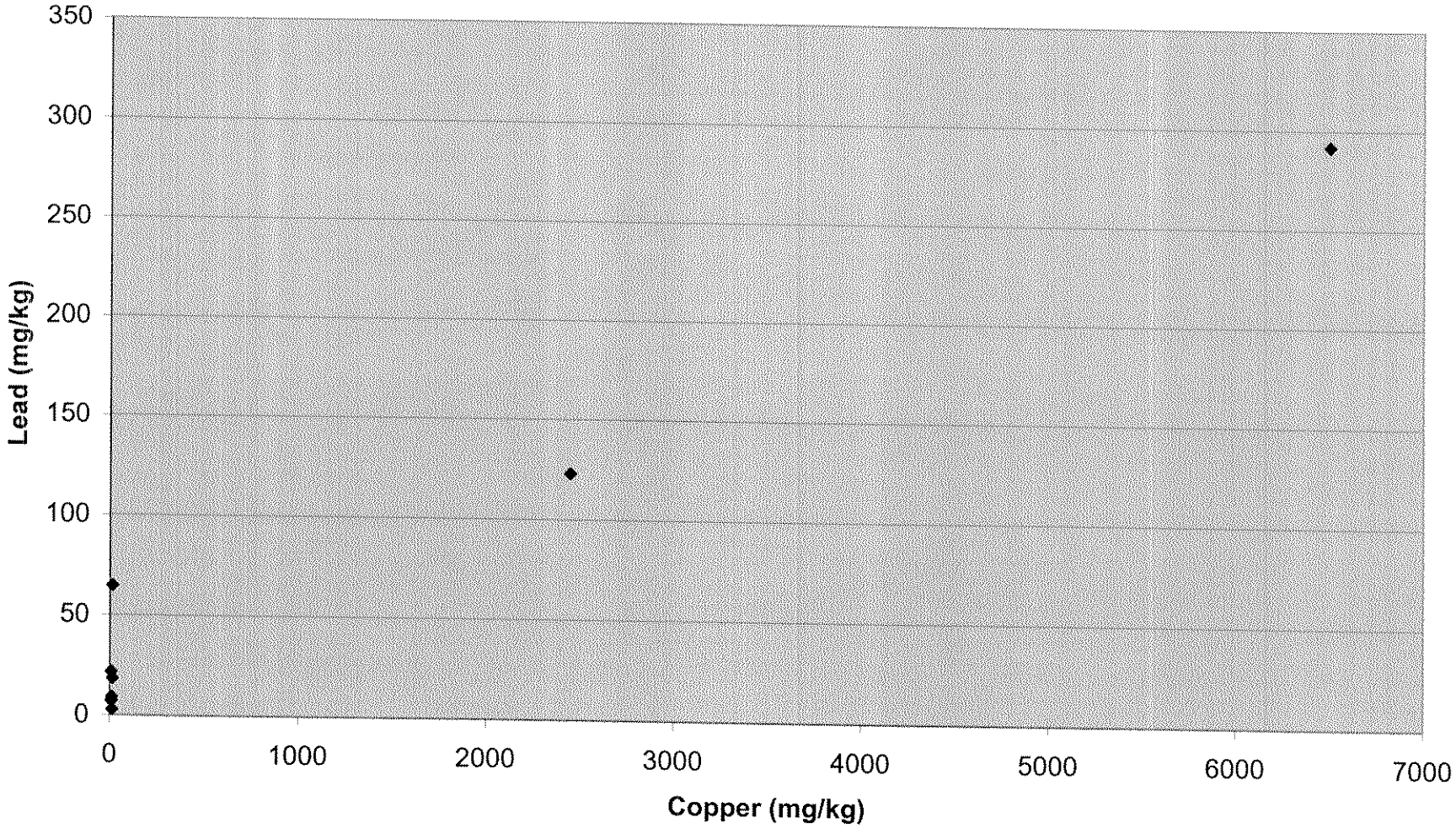

FIGURE 2. Comparison of Zinc (mg/kg) and Lead (mg/kg)
Northern Short-Tailed Shrew
Ringwood Mine Site

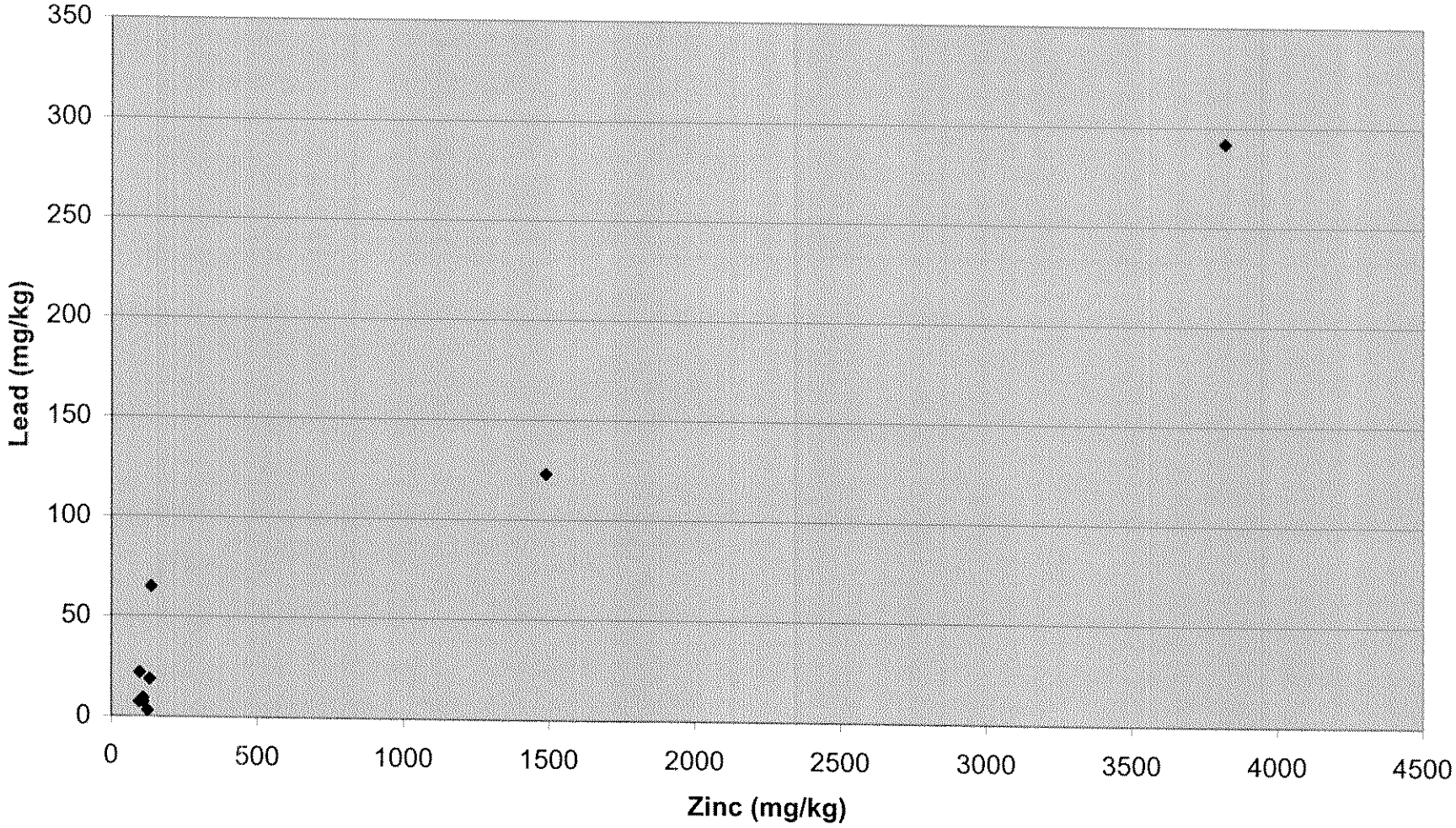

FIGURE 3. Comparison of Copper (mg/kg) and Lead (mg/kg)
White-Footed Mouse
Ringwood Mine Site

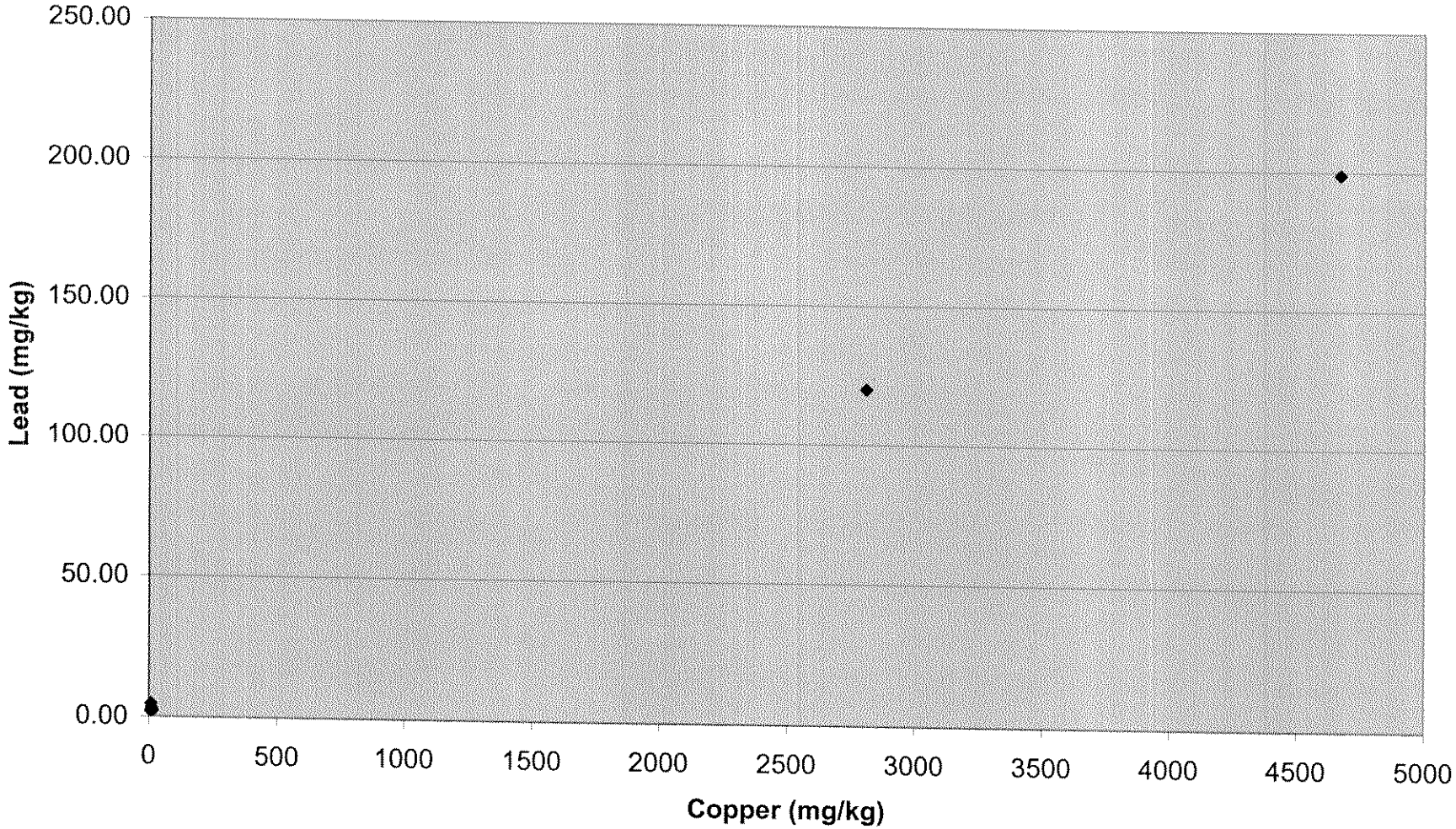

FIGURE 4. Comparison of Zinc (mg/kg) and Lead (mg/kg)
White-Footed Mouse
Ringwood Mine Site

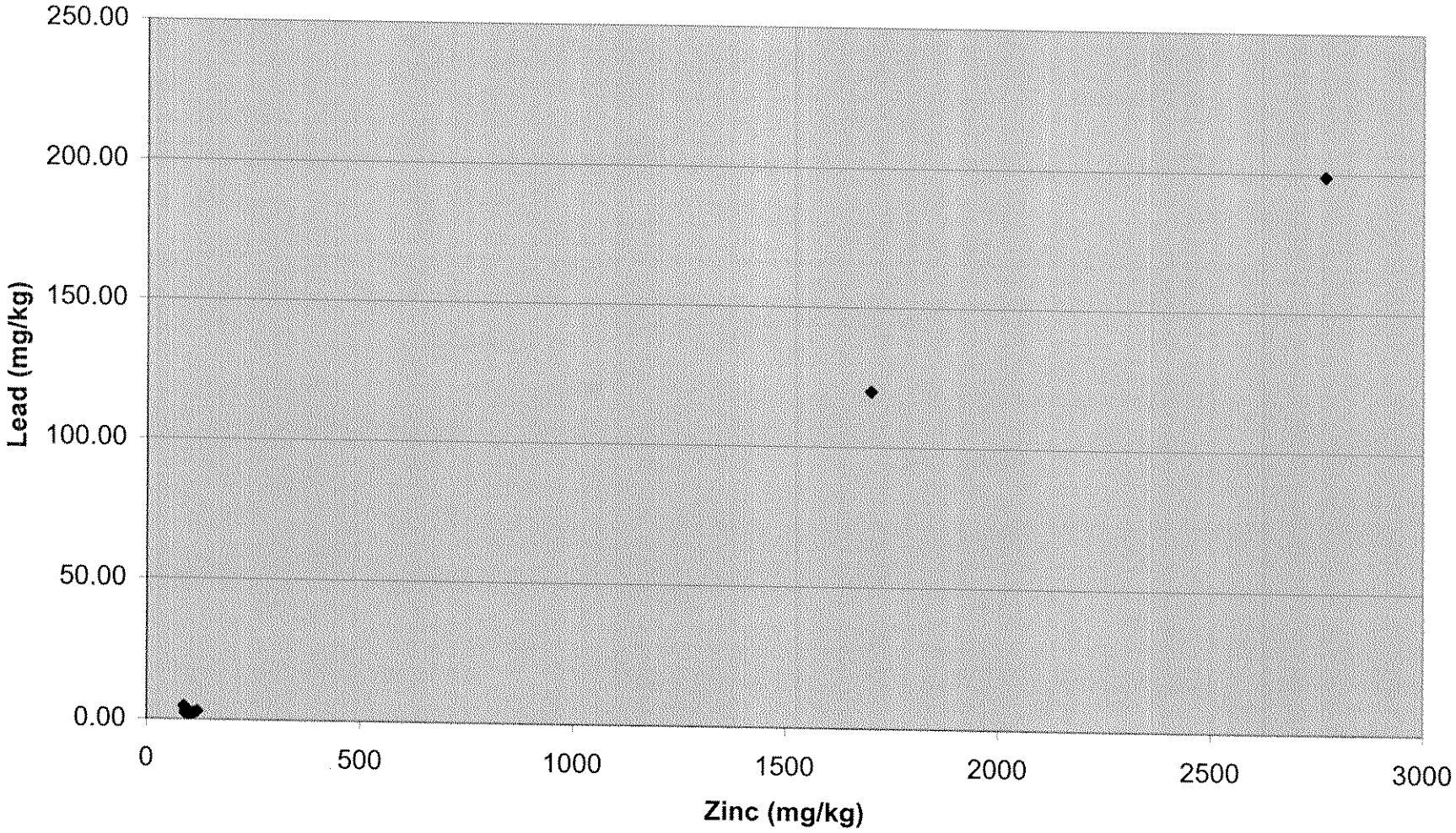

FIGURE 5. Comparison of Copper (mg/kg) and Lead (mg/kg)
Woodland Vole
Ringwood Mine Site

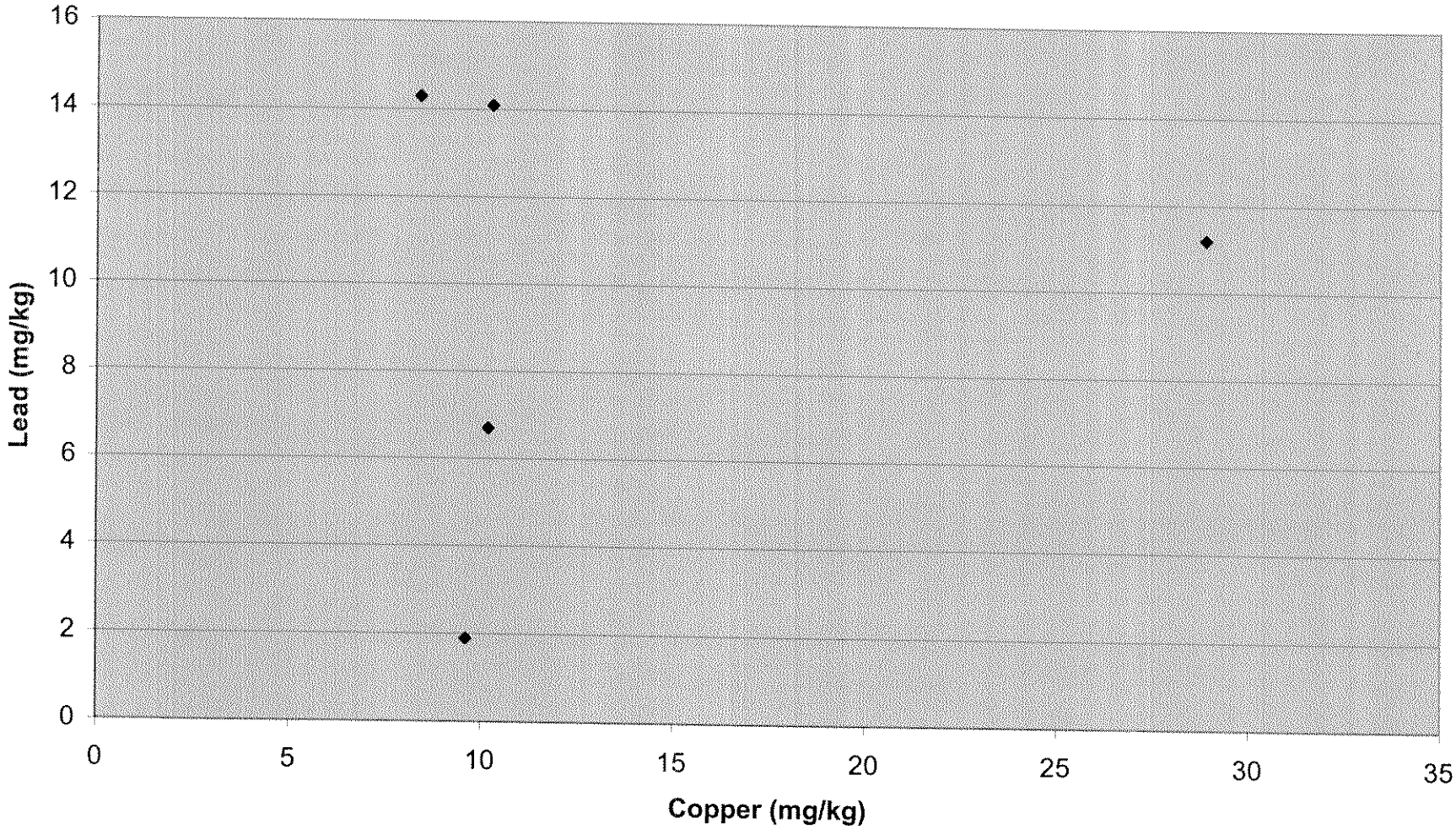

FIGURE 6. Comparison of Zinc (mg/kg) and Lead (mg/kg)
Woodland Vole
Ringwood Mine Site

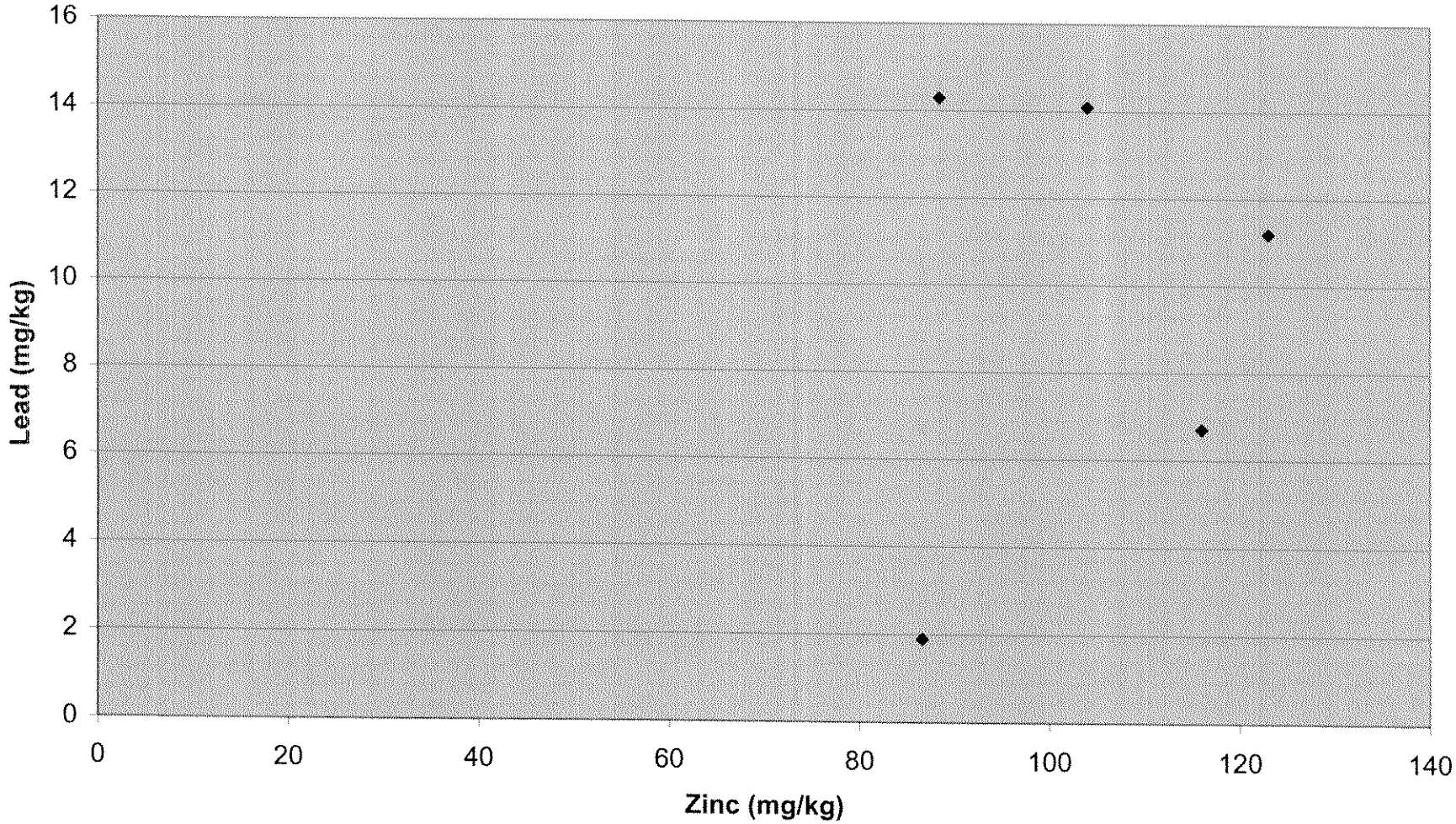

FIGURE 7. Comparison of Copper (mg/kg) and Lead (mg/kg)
Squirrel Tissue
Ringwood Mine Site

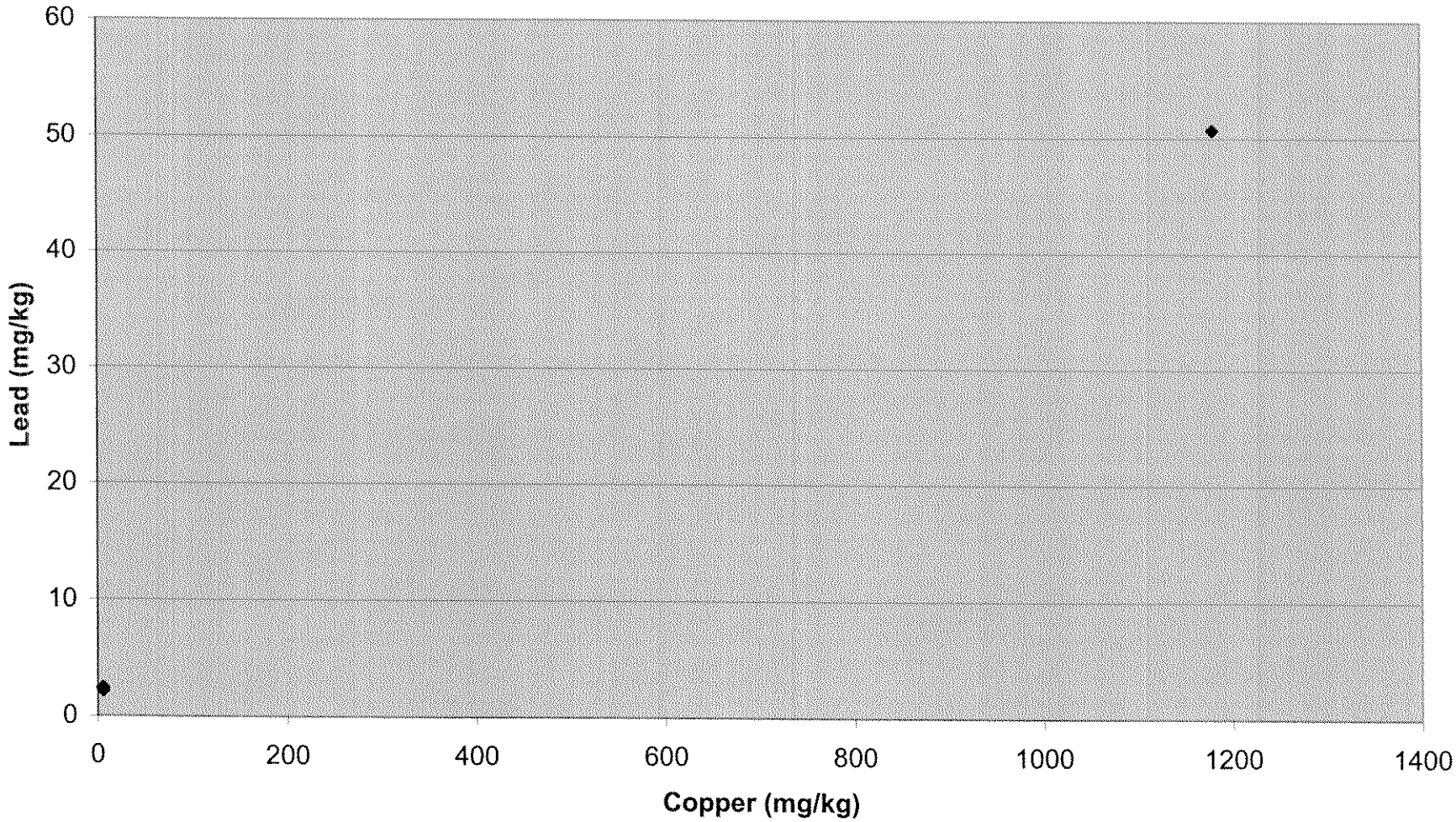

FIGURE 8. Comparison of Zinc (mg/kg) and Lead (mg/kg)
Squirrel Tissue
Ringwood Mine Site

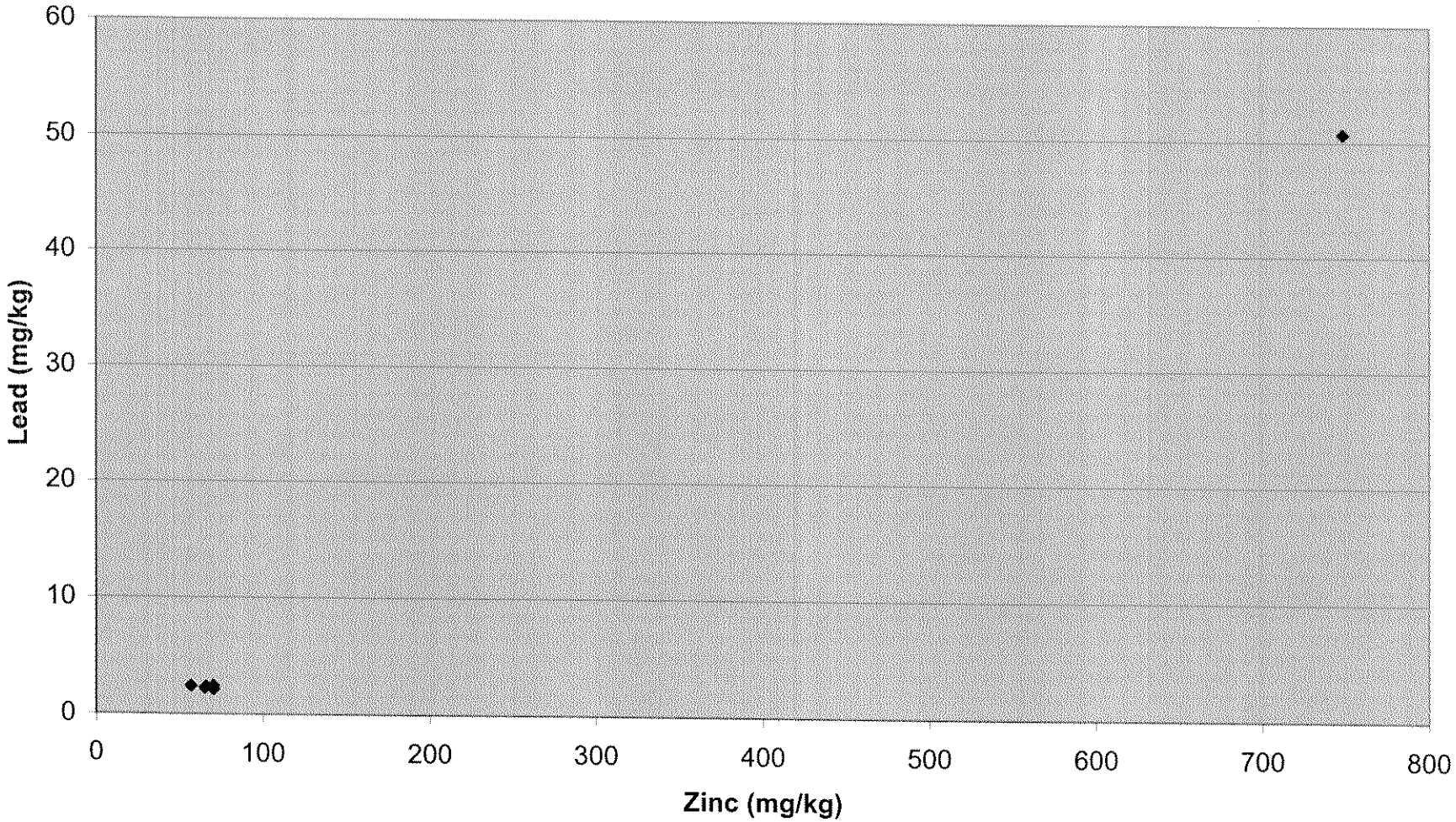

FIGURE 9. Comparison of Copper (mg/kg) and Lead (mg/kg)
Crayfish Tissue
Ringwood Mine Site

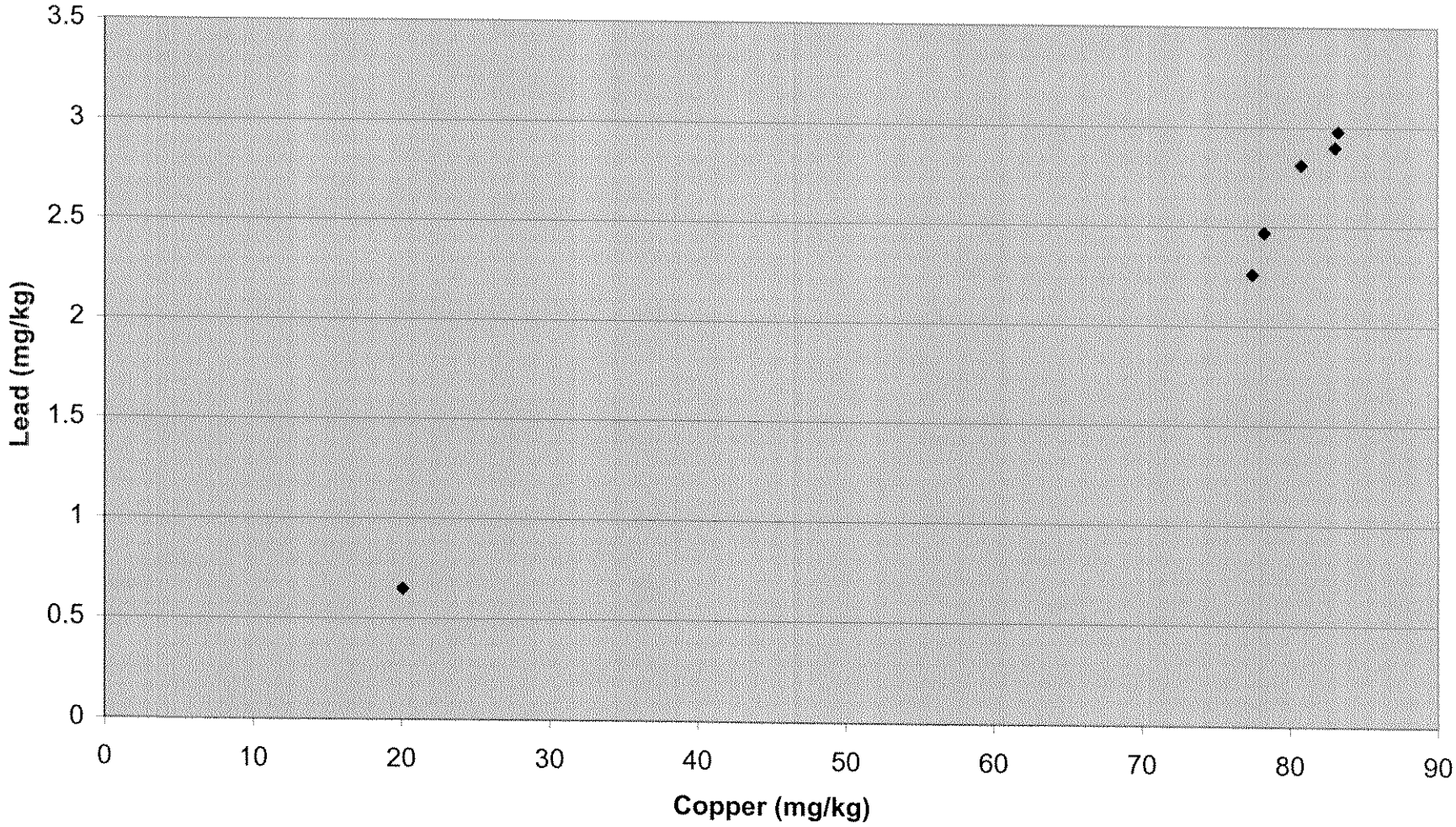

FIGURE 10. Comparison of Zinc (mg/kg) and Lead (mg/kg)
Crayfish Tissue
Ringwood Mine Site

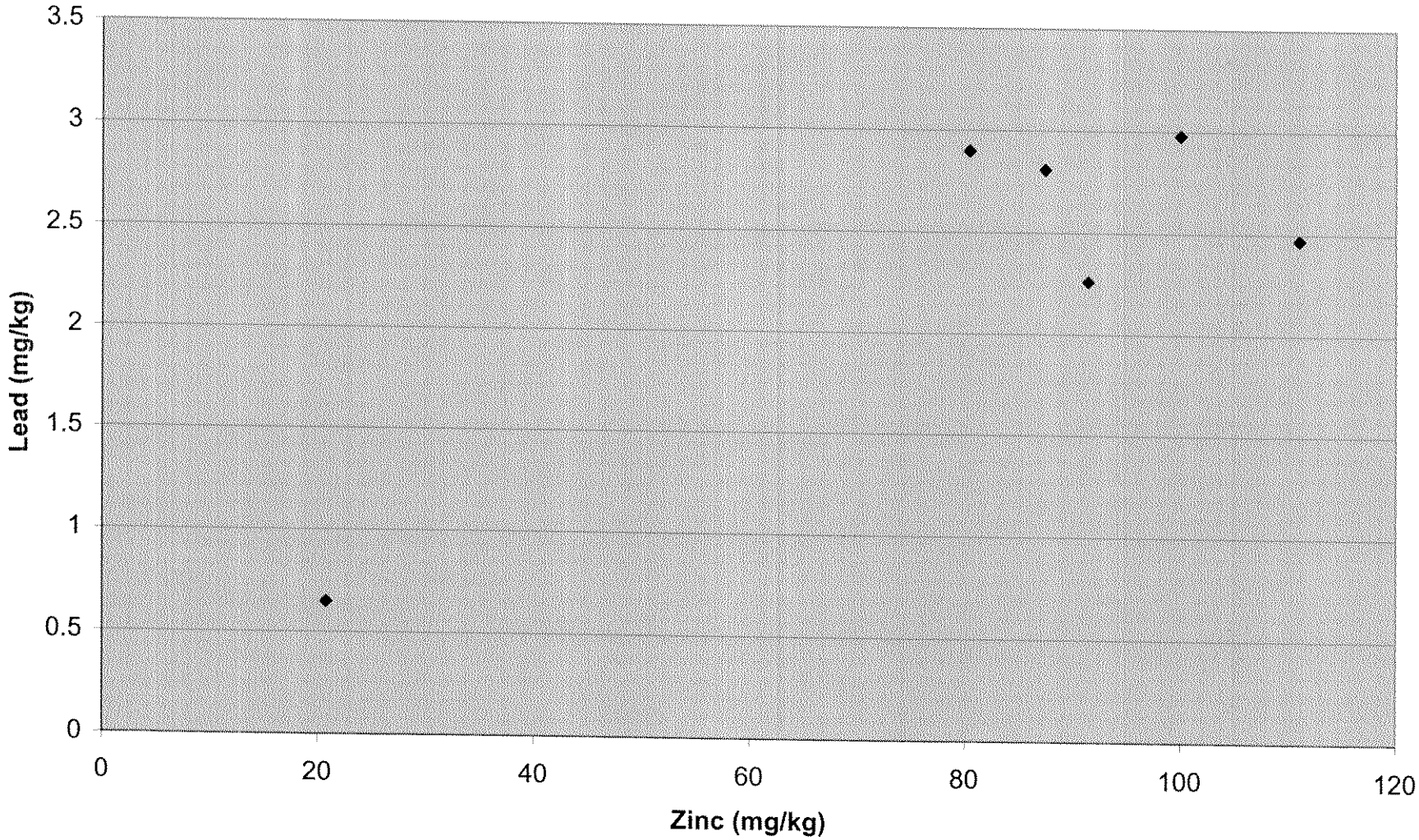

FIGURE 11. Comparison of Copper (mg/kg) and Lead (mg/kg)
Frog Tissue
Ringwood Mine Site

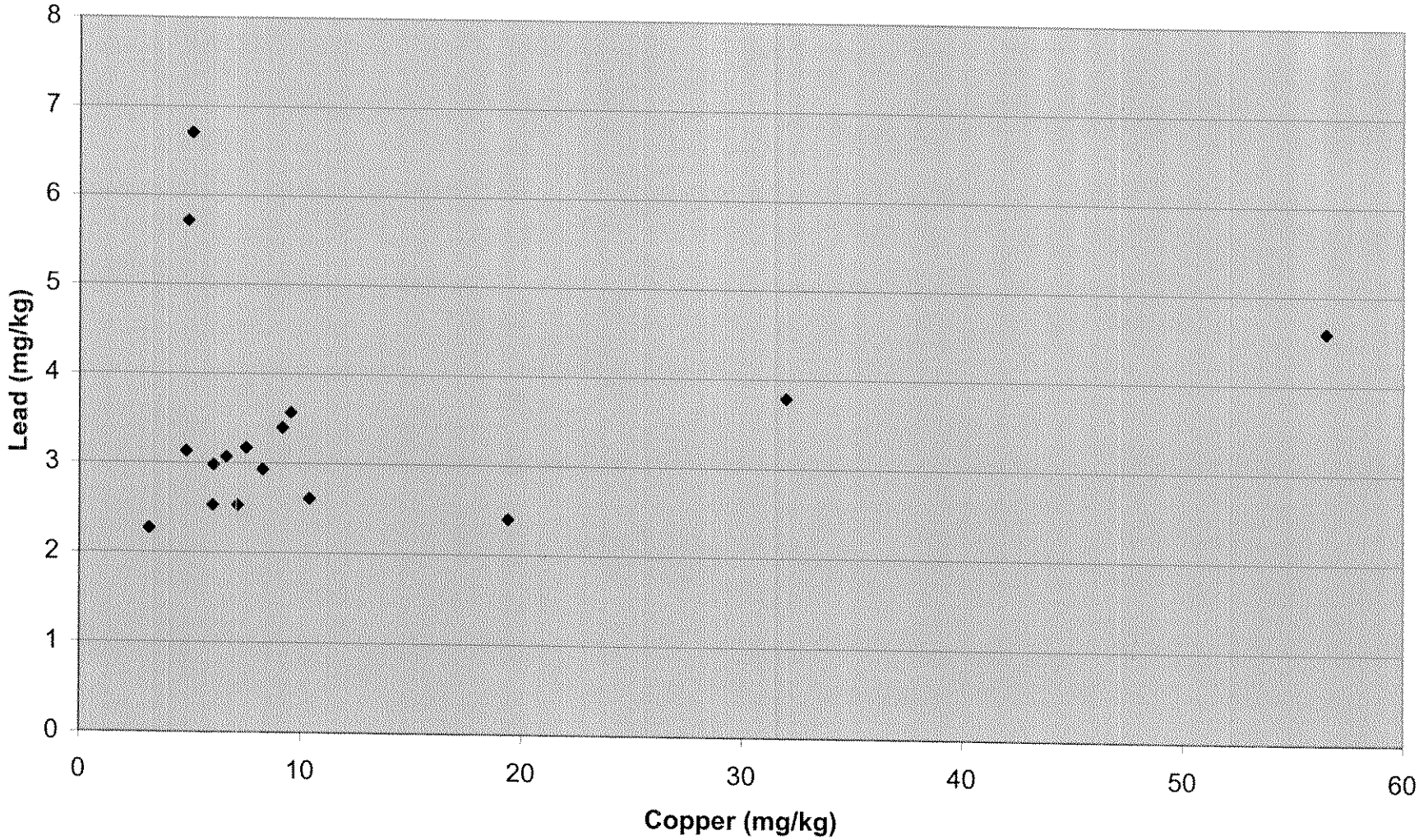

FIGURE 12. Comparison of Zinc (mg/kg) and Lead (mg/kg)
Frog Tissue
Ringwood Mine Site

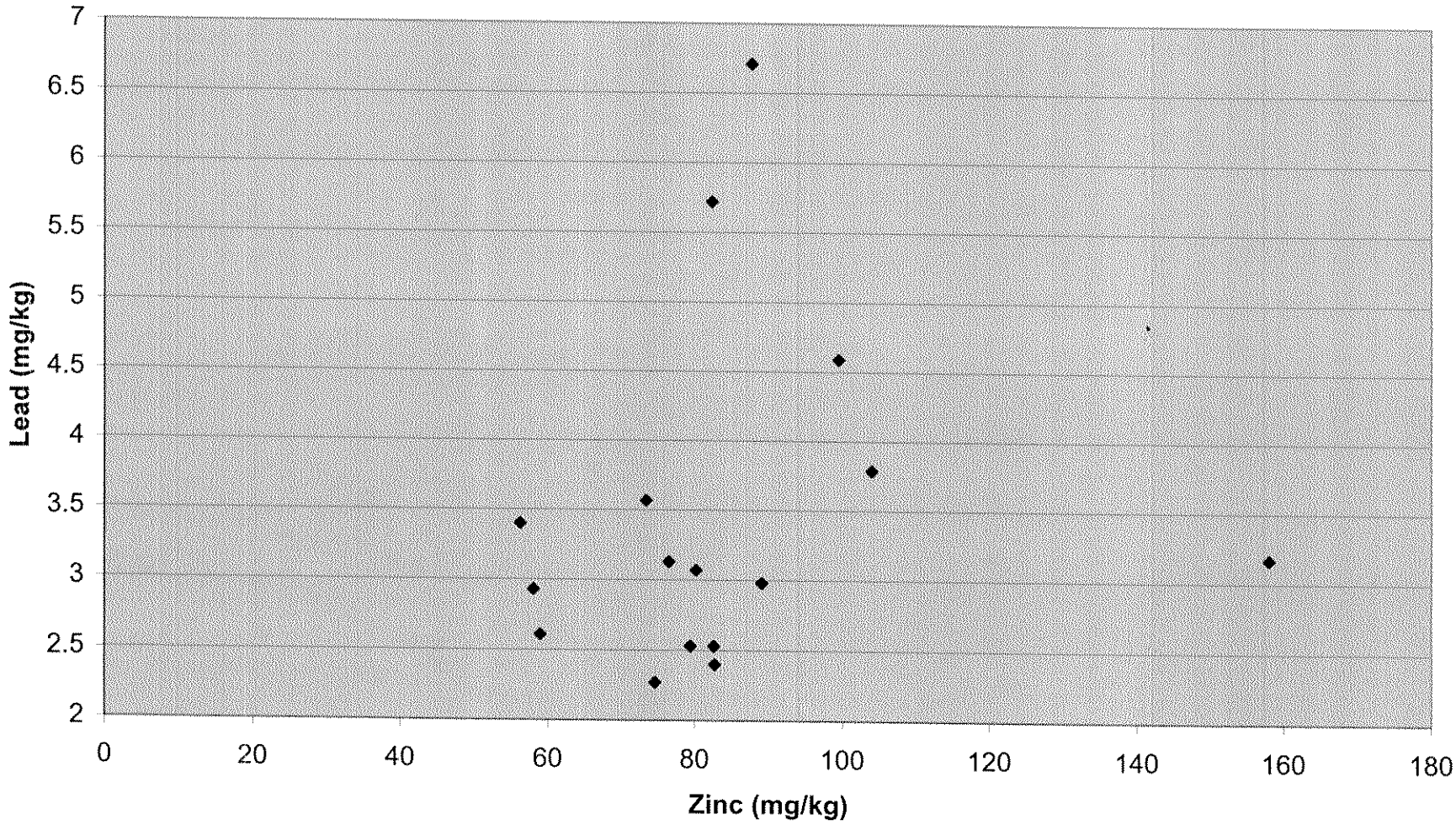

FIGURE 13. Comparison of Copper (mg/kg) and Lead (mg/kg)
Root Tissue
Ringwood Mine Site

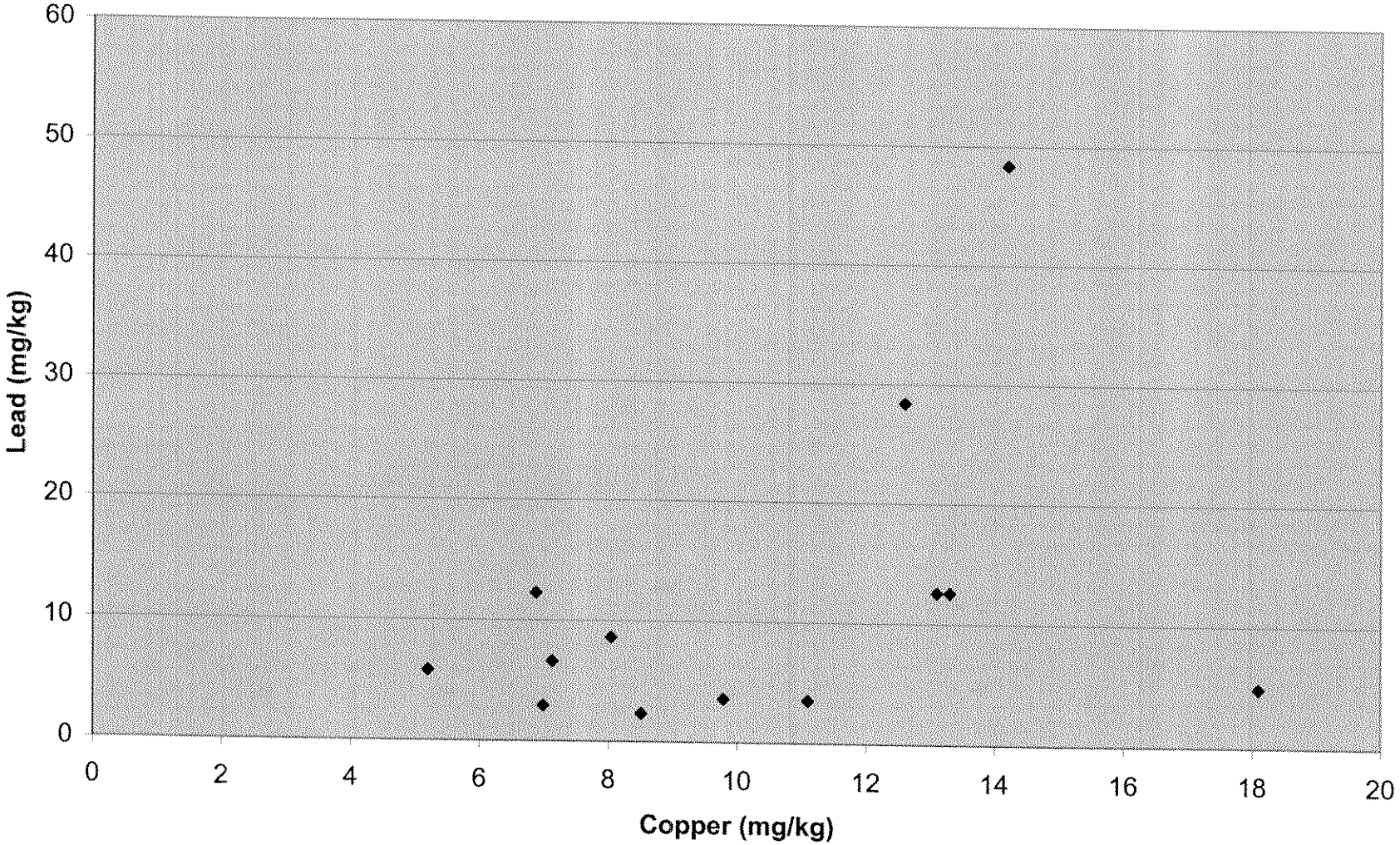

FIGURE 14. Comparison of Zinc (mg/kg) and Lead (mg/kg)
Root Tissue
Ringwood Mine Site